oil nozzle **152** is used in the embodiment of FIG. **7**. Reference is hereby made to parent application No. 08/092,008, filed Jul. 15, 1993, which, as noted above, is incorporated by reference herein, for a complete description of oil nozzle **152**.

As shown in FIG. **7**, the burner assembly **210** includes a nose portion or nose piece **90** provided with a central discharge orifice or annular opening **92**. An oil-delivery assembly **152** is shown centrally mounted within the oxygen-supply housing **16** by means of a spider or centering ring **154**. The fuel-delivery assembly **152** is shown to include an inlet body portion **155**, a central body portion **156**, and a burner tip portion **158**. A central fuel-oil passageway **160**, formed in a channel member **162**, is provided with an inlet connector for receiving a suitable supply of fuel such as oil.

The burner tip portion **158** forms a chamber **164** between a forward channel portion of the channel member **162** and the inner circumferential wall portion of the burner tip portion **158**. An atomizing member **166** is secured to an outlet end of the forward channel portion and projects within the central fuel-oil passageway **160**. The forward end of the burner tip portion **158** terminates at its outer end in a burner tip opening.

An atomizing fluid passage **168** extends through the inlet body portion **155** and central body portion **156** of the fuel assembly **152** exteriorly of channel member **162**, and communicates at its outlet end with the chamber **164** formed between the burner tip portion **158** and the channel member **162**. The atomizing fluid passage **168** is provided at its inlet end with a connector for receiving a suitable supply of atomizing fluid such as oxygen from atomizing fluid supply **169** coupled to atomizing fluid passage **168** by conduit **171**. The centering ring or spider **154** is provided with a plurality of openings or ports for the flow of oxygen outwardly along the outer surface of burner tip portion **158**.

An oxygen inlet **60** communicates with the oxygen-supply housing **16** which surrounds the central body portion **156** and the burner tip portion **158** of the fuel-delivery assembly **152**. A first portion **37** of the oxygen supplied to the housing **16** exits first aperture **66** formed in base wall **52** through the plurality of oxygen ports or openings formed in the spider or centering ring **154**, so as to provide an oxygen envelope about the atomized oil discharged from the outlet end of the fuel assembly **152**. A remaining portion **39** of the oxygen supplied to the housing **16** is diverted to flow through second apertures **68** formed in base wall **52** along a different path to reach flame **44** in the manner described above. Such diversion of combustion oxygen flow is an important feature of the staged oxygen-fuel burner assembly and contributes to the lowered nitrogen oxide emissions achieved by the burner assembly **210**.

Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of the invention as described and defined in the following claims.

I claim:

1. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame chamber to the outlet opening of the flame chamber,

an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to

include first aperture means for discharging oxygen from the chamber means into the flame chamber and second aperture means for discharging oxygen from the chamber means into the bypass means, and

means for discharging fuel into the flame chamber formed in the burner block, the discharging means including a nozzle extending through the chamber means and the first aperture means formed in the base wall to discharge fuel into the flame chamber.

2. The burner assembly of claim 1, wherein the oxygen-supply housing includes a hollow shell appended to the base wall to define the chamber means therebetween.

3. The burner assembly of claim 1, wherein the burner block is formed to include at least one oxygen-admission port lying adjacent to the base wall and communicating with the second aperture means and the bypass means is coupled to the oxygen-admission port and arranged to pass through the burner block to conduct oxygen from the chamber means through the burner block to the outlet opening of the flame chamber.

4. The burner assembly of claim 3, wherein the oxygen-supply housing further includes a frame located between the base wall and the burner block and coupled to the burner block and fastening means for connecting the base wall to the frame and the frame is formed to include at least one oxygen-conducting channel interconnecting the second aperture means and the bypass means in fluid communication.

5. The burner assembly of claim 4, wherein the second aperture means includes a plurality of wall apertures formed in the base wall and the burner block is formed to include an oxygen-admission port communicating with each wall aperture through one of the oxygen-conducting channels.

6. The burner assembly of claim 3, wherein the second aperture means includes a plurality of wall apertures formed in the base wall and the burner block is formed to include an oxygen-admission port communicating with each wall aperture.

7. The burner assembly of claim 6, further comprising frame means for supporting the burner block, the base wall being mounted on the frame means, and the frame means being formed to include oxygen-conducting channels interconnecting the wall apertures formed in the base wall and the oxygen-admission ports formed in the burner block.

8. The burner assembly of claim 1, wherein the nozzle is one of a gas-fuel nozzle and an oil-fuel nozzle.

9. The burner assembly of claim 1, wherein the chamber means formed in the oxygen-supply housing contains only the nozzle.

10. The burner assembly of claim 1, wherein only the nozzle passes through the first aperture means formed in the base wall.

11. The burner assembly of claim 1, wherein the base wall is rectangular, the first aperture means includes a first-stage aperture formed in a center portion of the rectangular base wall, and the second aperture means includes a second-stage aperture formed in each of four corner portions of the base wall and coupled to the bypass means.

12. The burner assembly of claim 1, wherein the discharging means further includes a removable collar engaging the nozzle and threadedly engaging the oxygen-supply housing.

13. The burner assembly of claim 12, wherein the oxygen-supply housing includes an annular lip defining a cylindrical nozzle aperture receiving the nozzle and the removable collar includes an annular side wall surrounding and engaging the annular lip.

14. The burner assembly of claim 1, wherein the first

aperture means includes a first-stage aperture formed in the base wall, the second aperture means includes at least one second-stage aperture formed in the base wall and arranged to lie in spaced-apart relation to the first-stage aperture, the bypass means includes at least one oxygen-conducting passageway formed in the burner block and arranged to receive oxygen conducted through a corresponding second-stage aperture, and the internal diameter of each second-stage aperture formed in the base wall is less than the internal diameter of a corresponding oxygen-conducting passageway formed in the burner block to regulate flow of oxygen through the oxygen-conducting passageways formed in the burner block.

15. The burner assembly of claim **14**, where the base wall is rectangular, the first-stage aperture is formed in a center portion of the rectangular base wall, and a second-stage aperture is formed in each of four corner portions of the rectangular base wall.

16. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame chamber to the outlet opening of the flame chamber,

means for discharging fuel into the flame chamber formed in the burner block, and

an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to include first aperture means for discharging oxygen from the chamber means into the flame chamber and second aperture means for discharging oxygen from the chamber means into the bypass means, the oxygen-supply housing including a hollow shell appended to the base wall to define the chamber means therebetween, wherein the hollow shell has a pyramidal shape and includes at least one triangular side wall appended to the base wall and formed to include an oxygen-admission port.

17. The burner assembly of claim **16**, wherein the chamber means formed in the oxygen-supply housing contains only the nozzle.

18. The burner assembly of claim **16**, wherein only the nozzle passes through the first aperture means formed in the base wall.

19. The burner assembly of claim **16**, wherein the hollow shell includes a tip and four triangular side walls diverging from the tip toward the base wall.

20. The burner assembly of claim **16**, wherein the base wall is rectangular, the first aperture means includes a first-stage aperture formed in a center portion of the rectangular base wall, and the second aperture means includes a second-stage aperture formed in each of four corner portions of the base wall and coupled to the bypass means.

21. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame chamber to the outlet opening of the flame chamber,

means for discharging fuel into the flame chamber formed in the burner block, and

an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to include first aperture means for discharging oxygen

from the chamber means into the flame chamber and second aperture means for discharging oxygen from the chamber means into the bypass means, the oxygen-supply housing including a hollow shell appended to the base wall to define the chamber means therebetween, wherein the hollow shell includes a tip and a side wall extending between the tip and the base wall, the tip is formed to include an aperture, and the discharging means includes a nozzle extending through the aperture formed in the tip and the first aperture means formed in the base wall and terminating in the inlet opening of the flame chamber.

22. The burner of claim 21, wherein the nozzle includes a fuel-discharge head, a mounting fixture, and means for metering oxygen flow, and the tip of the hollow shell is formed to include means for supporting the mounting fixture to position the fuel-discharge head in the inlet opening and the metering means at an interface between the first aperture means and the inlet opening to regulate oxygen flowing into the inlet opening and mixing with fuel discharged by the fuel-discharge head.

23. The burner assembly of claim 21, wherein the second aperture means includes a plurality of apertures formed in the base wall and each aperture is arranged to lie in radially spaced-apart relation to a portion of the nozzle extending through the first aperture means.

24. The burner assembly of claim 21, wherein the oxygen-supply housing further includes modular fastening means for selectively connecting the base wall to the burner block so that the oxygen-supply housing and the nozzle are joined together to form a modular unit containing the first and second aperture means that is removable from the burner block at the option of a user.

25. The burner assembly of claim 21, wherein the chamber means formed in the oxygen-supply housing contains only the nozzle.

26. The burner assembly of claim 25, wherein the frame is formed to include one oxygen-conducting channel for each of the apertures formed in the base wall and included in the second aperture means.

27. The burner assembly of claim 21, wherein the base wall is rectangular, the first aperture means includes a first-stage aperture formed in a center portion of the rectangular base wall, and the second aperture means includes a second-stage aperture formed in each of four corner portions of the base wall and coupled to the bypass means.

28. The burner assembly of claim 21, wherein discharging means further includes a removable collar engaging the tip of the hollow shell and the nozzle to retain the nozzle in a fixed position in the chamber means.

29. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame chamber to the outlet opening of the flame chamber,

means for discharging fuel into the flame chamber formed in the burner block, and

an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to include first aperture means for discharging oxygen from the chamber means into the flame chamber and second aperture means for discharging oxygen from the chamber means into the bypass means, the oxygen-supply housing further including a hollow shell appended to the base wall to define the chamber means

therebetween and modular fastening means for selectively connecting the base wall to the burner block to position the first aperture means in confronting relation to the inlet opening of the flame chamber so that the oxygen-supply housing can be disconnected from the burner block during rehabilitation of the burner assembly, the modular fastening means including a frame positioned to lie between the base wall and the burner block, means for coupling the frame to the burner block, and fasteners interconnecting the base wall and the frame.

30. The burner assembly of claim 29, wherein the frame is formed to include at least one oxygen-conducting channel interconnecting the second aperture means formed in the base wall and the bypass means.

31. The burner assembly of claim 29, wherein the base wall is rectangular, the first aperture means includes a first-stage aperture formed in a center portion of the rectangular base wall, the second aperture means includes a second-stage aperture formed in each of four corner portions of the base wall and coupled to the bypass means, and the frame is formed to include one oxygen-conducting channel for each of the first-stage and second-stage apertures.

32. The burner assembly of claim 29, wherein the second aperture means includes a plurality of apertures formed in the base wall, the bypass means includes a plurality of passageways formed in the burner block, and the frame is formed to include at least one oxygen-conducting channel interconnecting one of the plurality of apertures and the plurality of passageways in fluid communication.

33. The burner assembly of claim 29, wherein the second aperture means includes at least one second-stage aperture formed in the base wall, at least one oxygen-conducting channel formed in the frame and arranged to receive oxygen conducted through a corresponding second-stage aperture, the bypass means includes at least one oxygen-conducting passageway formed in the burner block and arranged to receive oxygen conducted through a corresponding second-stage aperture and oxygen-conducting channel, and the internal diameter of each second-stage aperture formed in the base wall is less than the internal diameter of both of a corresponding oxygen-conducting channel formed in the frame and a corresponding oxygen-conducting passageway formed in the burner block to regulate flow of oxygen through the oxygen-conducting passageways formed in the burner block.

34. The burner assembly of claim 29, wherein the burner block is formed to include a plurality of oxygen-conducting passageways defining the bypass means and an annular channel surrounding the inlet opening of the flame chamber and interconnecting each of the oxygen-conducting passageways, the frame includes means for covering the annular channel to define a circular oxygen-conducting passageway between the frame and the burner block and at least one oxygen-conducting channel interconnecting the second aperture means formed in the base wall and the circular oxygen-conducting passageway.

35. The burner assembly of claim 34, wherein the oxygen-conducting passageways formed in the burner block have an arcuate shape and terminate in annular openings formed in the burner block and arranged to lie around the outlet opening of the flame chamber formed in the burner block.

36. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame

chamber to the outlet opening of the flame chamber,

means for discharging fuel into the flame chamber formed in the burner block,

an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to include first aperture means for discharging oxygen from the chamber means into the flame chamber and second aperture means for discharging oxygen from the chamber means into the bypass means, the burner block being formed to include at least one oxygen-admission port lying adjacent to the base wall and communicating with the second aperture means and the bypass means being coupled to the oxygen-admission port and arranged to pass through the burner block to conduct oxygen from the chamber means through the burner block to the outlet opening of the flame chamber, the second aperture means including a plurality of wall apertures formed in the base wall, the burner block being formed to include an oxygen-admission port communicating with each wall aperture, and frame means for supporting the burner block, the base wall being mounted on the frame means, the burner block being formed to include an annular channel around the inlet opening of the flame chamber, the frame means including means for covering the annular channel to define an annular oxygen-conducting passageway therein and means for communicating oxygen discharged from the chamber means through the wall apertures to the annular oxygen-conducting passageway for delivery to the outlet opening of the flame chamber through the bypass means.

37. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame chamber to the outlet opening of the flame chamber,

means for discharging fuel into the flame chamber formed in the burner block, and

an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to include first aperture means for discharging oxygen from the chamber means into the flame chamber and second aperture means for discharging oxygen from the chamber means into the bypass means, the discharging means including a fuel discharge nozzle and means for fixing the fuel discharge nozzle in the inlet opening, the fixing means being positioned to lie between the base wall and the burner block, the fixing means being formed to include third aperture means for conducting oxygen discharged through the first aperture means into the flame chamber, the third aperture means defining a first-stage oxygen port having a first effective cross-sectional area and communicating oxygen from the chamber means into the flame chamber, the second aperture means defining a second-stage oxygen port having a second effective cross-sectional area less than the first effective cross-sectional area and communicating oxygen from the chamber means to the outlet opening of the flame chamber through the bypass means.

38. The burner assembly of claim 37, wherein the third aperture means includes a flange appended to the fuel discharge nozzle and formed to include the first-stage oxy-

gen port and the second aperture means includes a plurality of apertures formed in the base wall collectively to define the second-stage oxygen port.

39. The burner assembly of claim 38, wherein the flange is ring-shaped and is formed to include a plurality of apertures lying around the fuel-discharge nozzle and defining the first-stage oxygen port and each of the apertures formed in the base wall lies in radially spaced-apart relation to the fuel-discharge nozzle.

40. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

a nozzle including means for discharging fuel into the flame chamber formed in the burner block,

means for fixing the nozzle adjacent to the burner block to position the discharging means at the inlet opening of the flame chamber so that a primary combustion zone is established in the flame chamber between the inlet and outlet openings,

means for supplying oxygen to the flame chamber through the inlet opening so that the oxygen supplied by the supplying means mixes with the fuel discharged by the nozzle in a first-stage region inside the flame chamber to produce a combustible mixture that can be ignited in the primary combustion zone to define a flame having a root portion in the flame chamber and a tip portion outside the flame chamber,

first-stage metering means for metering the flow rate of oxygen from the supplying means into the flame chamber through the inlet opening, the first-stage metering means being appended to the nozzle,

bypass means for delivering oxygen from the supplying means into a downstream second-stage region containing a portion of the flame and lying outside the flame chamber to supplement oxygen supplied to the first-stage region inside the flame chamber by the supplying means, and

second-stage metering means for metering the flow rate of oxygen from the supplying means into the bypass means so that the downstream second-stage region outside the flame chamber through the bypass means is fixed in proportion to the flow rate of oxygen passing through the first-stage metering means.

41. The burner assembly of claim 40, wherein fixing means includes a ring-shaped flange positioned to lie around the nozzle and formed to include at least one oxygen-flow aperture defining the first-stage metering means.

42. The burner assembly of claim 41, wherein the supplying means includes an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block and the fixing means further includes a support fixture coupled to the base wall and the ring-shaped flange.

43. The burner assembly of claim 42 wherein the support fixture includes a mounting flange fixed between the base wall and the burner block and a nose portion formed to include a central aperture and the ring-shaped flange is positioned to lie in the central aperture and is coupled to the nose portion to support the nozzle in the inlet opening of the flame chamber.

44. The burner assembly of claim 40, wherein the supplying means includes an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block, the fixing means includes a support fixture having a mounting flange fixed between the

base wall and the burner block and a nose portion, the nose portion being formed to include a central opening receiving the nozzle, and the first-stage metering means includes a partition positioned to lie between the nozzle and the nose portion and formed to include the at least one oxygen-flow aperture.

45. The burner assembly of claim 44, wherein the partition is a ring-shaped flange surrounding the nozzle.

46. The burner assembly of claim 44, wherein the partition is positioned to lie in the central aperture of the nose portion.

47. The burner assembly of claim 40, wherein the supplying means includes an oxygen-supply housing including chamber means for receiving a supply of oxygen and a base wall adjacent to the burner block and the second-stage metering means includes at least one aperture formed in the base wall and arranged to interconnect to chamber means and the bypass means in fluid communication.

48. The burner assembly of claim 47, wherein the oxygen-supply housing includes a hollow shell appended to the base wall to define the chamber means therebetween.

49. The burner assembly of claim 48, wherein the base wall is formed to include first aperture means for discharging oxygen from the chamber means to the first-stage metering means, the hollow shell includes a tip and a side wall extending between the tip and the base wall, the tip is formed to include an aperture, the nozzle is mounted to extend through the aperture formed in the tip and the first aperture means formed in the base wall and to terminate in the outlet opening of the flame chamber, and the first-stage metering means includes a flow-metering ring appended to the nozzle and formed to include at least one oxygen-flow aperture.

50. The burner assembly of claim 40, wherein the nozzle includes a fuel-discharge head and a mounting fixture, the first-stage metering means is appended to the fuel-discharge head, the supplying means includes an oxygen-supply housing and the fixing means includes first support means for supporting the mounting fixture to position the fuel-discharge head in the inlet opening and second support means for supporting the first-stage metering means in a location between the oxygen-supply housing and the inlet opening.

51. The burner assembly of claim 50, wherein the supplying means includes an oxygen-supply housing including a hollow shell formed to include an aperture receiving the mounting fixture of the nozzle and the first support means includes a collar engaging the hollow shell to retain the mounting fixture in the aperture.

52. The burner assembly of claim 50, wherein the second support means includes a mounting flange fixed between the base wall and the burner block and a nose portion formed to include a central aperture receiving the fuel-discharge head.

53. The burner assembly of claim 50, wherein the first-stage metering means includes a ring positioned to lie around the fuel-discharge head and formed to include at least one oxygen-flow aperture.

54. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

bypass means for conducting oxygen outside of the flame chamber to the outlet opening of the flame chamber,

an oxygen-supply housing including chamber means for receiving a supply of oxygen,

frame means for coupling the oxygen-supply housing to the burner block,

a fuel nozzle module having a nozzle body and a dis-

charge tip, and

means for supporting the nozzle body of the fuel nozzle module in the chamber means to aim the discharge tip of the fuel nozzle module into the inlet opening of the flame chamber.

55. The burner assembly of claim **54**, wherein the oxygen-supply housing includes a hollow shell forming a boundary of the chamber means and the supporting means includes an aperture formed in the hollow shell and configured to receive the nozzle body therein and means for retaining the nozzle body in the aperture formed in the hollow shell so that the nozzle body is mounted inside the chamber means.

56. The burner assembly of claim **55**, wherein the supporting means further includes means for holding the discharge tip in a fixed position in the inlet opening of the flame chamber.

57. The burner assembly of claim **51**, wherein the oxygen-supply housing includes a base wall coupled to the hollow shell to define the chamber means therebetween and the holding means is coupled to the base wall.

58. The burner assembly of claim **54**, wherein the fuel nozzle module includes means for conducting fuel through the nozzle body and discharging fuel at the discharge tip.

59. The burner assembly of claim **54**, wherein the fuel nozzle module includes means for conducting separate streams of fuel and oxygen through the nozzle body and discharging an oxygen and fuel mixture using fuel and oxygen from the separate streams at the discharge tip.

60. A burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening, and

an oxygen-supply housing including a base wall and a hollow shell appended to the base wall to define an oxygen-supply chamber for receiving a supply of oxygen, the base wall being formed to include an oxygen-discharge aperture, the base wall being fixed to lie adjacent to the burner block to place the oxygen-discharge aperture in the base wall in fluid communication with the inlet opening in the burner block to allow oxygen to pass from the oxygen-supply chamber to the flame chamber through the oxygen-discharge aperture, the hollow shell having a pyramidal shape and a plurality of triangular side walls.

61. The burner assembly of claim **60**, wherein each triangular side wall has a wide base end and a narrow tip end, and the narrow tip ends of the triangular side walls cooperate to define a nozzle-receiving aperture, and further comprising a fuel-discharge nozzle mounted in the nozzle-receiving aperture and arranged to discharge fuel into the flame chamber through the inlet opening in the burner block.

62. The burner assembly of claim **61**, wherein the fuel-discharge nozzle is positioned to extend through the oxygen-discharge aperture formed in the base wall.

63. The burner assembly of claim **61**, wherein the wide base of each triangular side wall is appended to the base wall.

64. The burner assembly of claim **61**, further comprising a removable collar engaging the fuel-discharge nozzle and threadedly engaging a threaded rim appended to the narrow tip ends of the triangular side walls.

65. The burner assembly of claim **60**, further comprising a connector coupled to the oxygen-supply housing and the burner block to mount the oxygen-supply housing on the burner block.

66. The burner assembly of claim **65**, wherein the connector includes a frame positioned to lie between the base wall and the burner block and formed to include an oxygen-

conductor passageway interconnecting the oxygen-discharge aperture formed in the base wall and the inlet opening formed in the burner block.

67. The burner assembly of claim 66, wherein the base wall is formed to include another oxygen-discharge aperture communicating with the oxygen-supply chamber, the burner block is formed to include an oxygen-conducting passageway having an outlet in the frame chamber and an inlet, and the frame is formed to include a bypass passageway inter-

connecting said another oxygen-discharge aperture formed in the base wall and said oxygen-conducting passageway formed in the burner block.

68. The burner assembly of claim **66**, wherein the connector further includes at least one fastener coupled to the base wall and frame.

* * * * *

69. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

an oxygen conductor conduit configured to conduct oxygen along a route outside of the flame chamber to the outlet opening of the flame chamber,

an oxygen-supply housing defining an oxygen chamber configured to receive a supply of oxygen and a base wall positioned to lie adjacent to the burner block, the base wall being formed to include a first-stage aperture positioned to lie in alignment with the inlet opening and to pass oxygen from the oxygen chamber into the flame chamber and a second-stage aperture arranged to lie in spaced-apart relation to the first-stage aperture to pass oxygen from the oxygen chamber into the oxygen conductor conduit, the internal diameter of the second-stage aperture being less than the internal diameter of the oxygen conductor conduit to regulate the flow of oxygen from the oxygen chamber through the oxygen conductor conduit, and

a fuel-discharge nozzle positioned to lie adjacent to the inlet opening and configured to discharge fuel into the flame chamber formed in the burner block.

70. The burner assembly of claim 69, wherein the base wall is formed to include a plurality of second-stage apertures and the burner block is formed to include at least one inlet opening lying adjacent to the base wall and communicating with each second-stage aperture.

71. The burner assembly of claim 70, wherein the oxygen conductor conduit includes a plurality

of oxygen-conducting passageways formed in the burner block and each oxygen-conducting passageway corresponds to and communicates with one of the second-stage apertures formed in the base wall.

72. The burner assembly of claim 71, further comprising a frame supporting the burner block and wherein the base wall is mounted on the frame, the oxygen conductor conduit further includes oxygen-conducting channels formed in the frame, and the oxygen-conducting channels interconnect the second-stage apertures formed in the base wall and the inlet openings formed in the burner block.

73. The burner assembly of claim 70, wherein the base wall is rectangular, the first-stage aperture is formed in a center portion of the rectangular base wall and one second-stage aperture in each of four corner portions of the base wall.

74. The burner assembly of claim 69, further comprising a frame coupled to the burner block and positioned to lie adjacent the base wall and a fastener configured to connect the base wall to the frame and wherein the oxygen conductor conduit includes an oxygen-conducting channel formed in the frame and arranged to interconnect the second-stage aperture and the oxygen-conducting passageway.

75. The burner assembly of claim 69, wherein the fuel-discharge nozzle passes through the first-stage aperture formed in the base wall.

76. The burner assembly of claim 69, wherein the oxygen-supply housing includes a hollow shell appended to the base wall to define the oxygen chamber therebetween.

77. The burner assembly of claim 76, wherein the hollow shell has a pyramidal shape and includes at least

~~one triangular side wall appended to~~ the base wall and formed to include an oxygen-admission port.

78. The burner of claim 76, wherein the hollow shell includes a tip and a side wall extending between the tip and the base wall, the tip is formed to include an aperture, and the fuel-discharge nozzle extends through the aperture formed in the tip and the first-stage aperture formed in the base wall and terminates in the inlet opening of the flame chamber.

79. The burner of claim 78, wherein the fuel-discharge nozzle includes a fuel-discharge head positioned to lie in the inlet opening, a mounting fixture, and a flow-metering device positioned to lie at an interface between the first-stage aperture and the inlet opening to regulate oxygen flowing into the inlet opening and mixing with fuel discharged by the fuel-discharge head.

80. The burner assembly of claim 79, wherein the base wall is formed to include a plurality of second-stage apertures and each second-stage aperture is arranged to lie in radially spaced-apart relation to a portion of the fuel-discharge nozzle extending through the first-stage aperture.

81. The burner assembly of claim 79 wherein the oxygen-supply housing further includes a fastener configured to selectively connect the base wall to the burner block so that the oxygen-supply housing and the fuel-discharge nozzle are joined together to form a modular unit containing the first-stage aperture and the second-stage aperture that is removable from the burner block at the option of a user.

82. The burner of claim 76, further comprising a frame selectively coupled to the burner block and positioned to lie adjacent to the base

wall and a fastener configured to selectively connect the base wall to the frame to position the first-stage aperture in confronting relation to the inlet opening of the flame chamber so that the oxygen-supply housing can be disconnected from the burner block during rehabilitation of the burner assembly.

83. The burner of claim 82, wherein the burner block is formed to include an annular channel extending around the inlet opening of the flame chamber.

84. The burner of claim 83, wherein the frame covers the annular channel to define an annular oxygen-conducting passageway therein forming a portion of the oxygen conductor conduit and communicates oxygen discharged from the chamber through the second-stage apertures to the annular oxygen-conducting passageway for delivery to the outlet opening of the flame chamber through the oxygen conductor conduit.

85. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

an oxygen conductor conduit configured to conduct oxygen outside of the flame chamber to the outlet opening of the flame chamber,

an oxygen-supply housing defining an oxygen chamber configured to receive a supply of oxygen and a base wall positioned to lie adjacent to the burner block, the base wall being formed to include a first-stage aperture in alignment with the inlet opening to pass oxygen from the oxygen chamber into the flame chamber and a second-stage aperture arranged to lie in spaced-apart relation to the first-stage aperture to pass

oxygen from the oxygen chamber into the oxygen conductor conduit, and

a fuel-discharge nozzle extending through the oxygen chamber and the first-stage aperture formed in the base wall to discharge fuel into the flame chamber.

86. The burner assembly of claim 85, wherein the oxygen-supply housing includes a hollow shell appended to the base wall to define the oxygen chamber therebetween.

87. The burner assembly of claim 85, wherein the burner block is formed to include at least one oxygen inlet lying adjacent to the base wall and communicating with the second-stage aperture and the oxygen conductor conduit is coupled to the oxygen inlet and arranged to pass through the burner block to conduct oxygen from the oxygen chamber through the burner block to the outlet opening of the flame chamber.

88. The burner assembly of claim 87, wherein the oxygen-supply housing further includes a frame located between the base wall and the burner block and coupled to the burner block and a fastener connecting the base wall to the frame and the oxygen conductor conduit includes at least one oxygen-conducting channel formed in the frame and connected to the second-stage aperture.

89. The burner assembly of claim 88, wherein the base wall is formed to include a plurality of second-stage apertures and the burner block is formed to include an inlet opening communicating with each second-stage aperture through one of the oxygen-conducting channels.

90. The burner assembly of claim 87, wherein the base wall is formed to include a plurality of second-stage apertures and the burner block is formed to include an inlet opening communicating with each

second-stage aperture through one of the oxygen-conducting channels.

91. The burner assembly of claim 90, further comprising a frame supporting the burner block, the base wall being mounted on the frame, and the oxygen conductor conduit including oxygen-conducting channels formed in the frame to interconnect the second-stage apertures formed in the base wall and the oxygen inlets formed in the burner block.

92. The burner assembly of claim 85, wherein the oxygen chamber formed in the oxygen-supply housing contains only the fuel-discharge nozzle.

93. The burner assembly of claim 85, wherein only the fuel-discharge nozzle passes through the first-stage aperture formed in the base wall.

94. The burner assembly of claim 85, wherein the base wall is rectangular, the first-stage aperture is formed in a center portion of the rectangular base wall, and the second-stage aperture is formed in each of four corner portions of the base wall and coupled to the oxygen conductor conduit.

95. The burner assembly of claim 85, further comprising a removable collar engaging the fuel-discharge nozzle and threadedly engaging the oxygen-supply housing.

96. The burner assembly of claim 95, wherein the oxygen-supply housing includes an annular lip defining a cylindrical nozzle aperture receiving the fuel-discharge nozzle and the removable collar includes an annular side wall surrounding and engaging the annular lip.

97. The burner assembly of claim 85, wherein first-stage aperture is formed in the base wall, the second-stage aperture is formed in the base wall and arranged to lie in

spaced-apart relation to the first-stage aperture, the oxygen conductor conduit includes at least one oxygen-conducting passageway formed in the burner block and arranged to receive oxygen conducted through a corresponding second-stage aperture, and the internal diameter of each second-stage aperture formed in the base wall is less than the internal diameter of a corresponding oxygen-conducting passageway formed in the burner block to regulate flow of oxygen through the oxygen-conducting passageways formed in the burner block.

98. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

an oxygen-conductor conduit configured to conduct oxygen outside of the flame chamber to the outlet opening of the flame chamber,

a fuel-discharge nozzle positioned to lie in the inlet opening and configured to discharge fuel into the flame chamber of the burner block,

an oxygen-supply housing defining an oxygen chamber configured to receive a supply of oxygen and a base wall positioned to lie adjacent to the burner block, the base wall being formed to include a first-stage aperture positioned to pass oxygen from the oxygen chamber into the flame chamber and a second-stage aperture positioned to pass oxygen from the oxygen chamber into the oxygen conductor conduit, the second-stage aperture defining a second-stage oxygen port having a first effective cross-sectional area and communicating oxygen from the chamber to the outlet opening of the

flame chamber through the oxygen conducting passageway, and

a flange positioned to lie between the base wall and the burner block and to extend about the fuel-discharge nozzle to fix the fuel-discharge nozzle in the inlet opening, the flange being formed to include a third-stage aperture for conducing oxygen discharged through the first-stage aperture into the flame chamber, the third-stage aperture defining a first-stage oxygen port having a second effective cross-sectional area that is greater than the first effective cross-sectional area and communicating oxygen from the oxygen chamber into the flame chamber.

99. The burner assembly of claim 98, wherein the base wall is formed to include a plurality of second-stage apertures that collectively define the second-stage oxygen port.

100. The burner assembly of claim 99, wherein the flange is ring-shaped and is formed to include a plurality of apertures lying around the fuel-discharge nozzle and defining the first-stage oxygen port and each of the apertures formed in the base wall lies in radially spaced-apart relation to the fuel-discharge nozzle.

101. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

a fuel-discharge nozzle positioned to lie in the inlet opening and configured to discharge fuel into the flame chamber formed in the burner block,

a flange positioned to lie around the fuel-discharge nozzle to situate the fuel-discharge nozzle

adjacent to the burner block at the inlet opening of the flame chamber so that a primary combustion zone is established in the flame chamber between the inlet and outlet openings and the flange is formed to include at least one oxygen-flow aperture therethrough,

an oxygen-supply housing including an oxygen chamber configured to receive a supply of oxygen and a base wall adjacent to the burner block, the base wall being formed to include a first-stage aperture sized to supply oxygen to the flame chamber through the inlet opening so that the oxygen supplied by the first-stage aperture mixes with the fuel discharged by the fuel-discharge nozzle in a first-stage region inside the flame chamber to produce a combustible mixture that can be ignited in the primary combustion zone to define a flame having a root portion in the flame chamber and a tip portion outside the flame chamber,

a partition positioned to lie between the fuel-discharge nozzle and the flange and formed to include at least one oxygen-flow aperture therethrough, the partition being configured to meter the flow rate of oxygen from the oxygen chamber into the flame chamber through the inlet opening, the partition being appended to the fuel-discharge nozzle,

an oxygen conductor conduit configured to conduct oxygen from the oxygen chamber into a downstream second-stage region containing a portion of the flame and lying outside the flame chamber to supplement oxygen supplied to the first-stage region inside the flame chamber by the first-stage aperture, and

at least one aperture formed in the base wall and arranged to interconnect the oxygen chamber and the oxygen conductor conduit in fluid communication, the at least one

aperture being sized to meter the flow rate of oxygen from the oxygen chamber into the oxygen conductor conduit so that the flow rate of oxygen passing the downstream second-stage region outside the flame chamber through the oxygen conductor conduit is fixed in proportion to the flow rate of oxygen passing through the partition.

102. The burner assembly of claim 101, wherein the flange is ring-shaped.

103. The burner assembly of claim 102, wherein the flange includes a support fixture coupled to the base wall.

104. The burner assembly of claim 103, wherein the support fixture includes a mounting flange fixed between the base wall and the burner block and a nose portion formed to include a central aperture and the ring-shaped flange is positioned to lie in the central aperture and is coupled to the nose portion to support the fuel-discharge nozzle in the inlet opening of the flame chamber.

105. The burner assembly of claim 101, wherein the flange includes a support fixture having a mounting flange fixed between the base wall and the burner block and a nose portion, the nose portion being formed to include a central opening receiving the fuel-discharge nozzle.

106. The burner assembly of claim 96, wherein the partition is a ring-shaped flange surrounding the fuel-discharge nozzle.

107. The burner assembly of claim 105, wherein the partition is positioned to lie in the central aperture of the nose portion.

108. The burner assembly of claim 101, wherein the fuel-discharge nozzle includes a fuel-discharge head and a mounting fixture, the partition is appended to the fuel-discharge head.

and the flange supports the mounting fixture to position the fuel-discharge head in the inlet opening and supports the partition in a location between the oxygen-supply housing and the inlet opening.

109. The burner assembly of claim 108, wherein the oxygen-supply housing includes a hollow shell formed to include an aperture receiving the mounting fixture of the fuel-discharge nozzle and the flange includes a collar engaging the hollow shell to retain the mounting fixture in the aperture.

110. A burner assembly for combining oxygen and fuel to produce a flame, the burner assembly comprising

a burner block formed to include a flame chamber having an inlet opening and an outlet opening,

an oxygen conductor conduit configured to conduct oxygen outside of the flame chamber to the outlet opening of the flame chamber,

an oxygen-supply housing including a hollow shell defining an oxygen chamber configured to receive a supply of oxygen, the hollow shell being formed to include an aperture therein,

a frame configured to couple the oxygen-supply housing to the burner block,

a fuel nozzle module having a nozzle body and a discharge tip, the fuel nozzle module extending through the aperture formed in the hollow shell to aim the discharge tip of the fuel nozzle module into the inlet opening of the flame chamber.

ADD a4

ADD C9

The oxygen-conducting channels formed in frame 14 and the oxygen-conducting passageways 40, 41, 42 and 43 formed in the burner block 12 cooperate to define an oxygen conductor conduit configured to conduct oxygen from the second apertures 68 formed in the base wall 52 to the second-stage combustion zone 114.

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